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EFFECT OF NATURAL DIETARY FIBERS (WHEAT PORRIDGE) ON HYPERLIPIDEMIA RATS

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Dietary fibers are indigestible portions of plant that are structural and storage polysaccharides. They are unable to digest by human gastro intestine due to lack of enzymes essential for digestion. Hyperlipidemia is a state characterized by the elevated level of any or all lipids and/or lipoproteins in the blood. This research is designed to study the effect of wheat porridge on hyperlipidemia, blood glucose level and body weight. Rat's species were selected as human representative. Elevated lipids level (total cholesterol, high density lipoproteins, low density lipoproteins and triglycerides) raise the risk of coronary heart diseases. Twenty four hyperlipidemia rats were randomly divided into four groups. Each group was provided wheat porridge with different concentration while first group was considered as control group. Blood samples were collected to examine lipid profile and sugar level. Body weight was also measured. Thus the data was subjected to analysis of variance. The present study was conducted to determine the effect of natural dietary fiber wheat porridge on lipid profile, body weight and serum glucose level. Wheat porridge showed minor reduction in body weight, serum glucose and serum triglycerides and also little rise high density lipoprotein but the results were insignificant. While significant decrease was shown in serum cholesterol and low density lipoprotein.
Keywords: Dietary fibers, Hyperlipidemia, Proximate composition, Glucose, Cholesterol

INTRODUCTION

Wheat is the second most important cereal crop in the world belonging to the genus Triticum (Gramineae) (Bajaj, 1990). In the whole wheat, bran forms 14.5 percent. Bran is enriched with minerals approximately over fifty percent mineral contents are present in bran. Bran enhances the nutritional value of wheat (Beaugrand *et al.*, 2004).The whole wheat flour generally contains 13 percent moisture, 69 percent carbohydrates, 12.2 percent protein, 2.3 percent fat and 2 percent fiber (FAO, 1989).

Human gastrointestinal enzymes are unable to digest these dietary fibers consisting of structural and storage polysaccharides (Judith *et al.,* 2002). Depending upon solubility property dietary fibers can be categorized in two groups; soluble and insoluble dietary fiber (Papathanasopoulos and Camilleri, 2010). Cellulose, lignin and some hemicelluloses are not soluble in humans and characterized as the structural or matrix fiber while pectin, gums, mucilage and the remainder hemicelluloses are soluble natural gel forming fibers (Munter *et al.,* 2007).

These two groups of dietary fiber are helpful in offering many physiological benefits such as reduction in the absorption of cholesterol, annihilation of the postprandial glucose absorption, fastening and dilution of cancer-causing agents from foods, water-holding and bulking of feces to lessen the constipation and alteration of bacterial flora so that smaller number of unsafe mutagenic compounds are formed (Jacob, 1998; Gallaher, 2001).

Oats, barley, beans and apples are source of soluble fibers and wheat and wheat products supply insoluble fibers (Mckee and Latner, 2000). Fiber rich diets have high protein-carbohydrate proportion (Jekins *et al.,* 2000).

Elevated cholesterol level is hyperlipidemia that leads to atherosclerosis (Nicolosi *et al.,* 2001). Serum cholesterol concentration is influenced by a number of dietary factors including dietary cholesterol, fat, and dietary fibers.

Cohort metabolic studies indicate that high-carbohydrate diets raise the fasting triglycerides and lipoprotein triglycerides and lipoprotein cholesterol in plasma (Jeppesen *et al*., 1997). High carbohydrate diets convert the excess carbohydrate into triglyceroles that increases the fat accretion and reduces the fat oxidation (Aarsland *et al*., 1997; Hudgins *et al*., 1998). Carbohydrates utilization enhances the production of very low density lipoproteins in the liver and decreases the lipoproteins lipase activity that induces hypertriglyceridemia (Liu *et al.,* 2001).

The swiftness of carbohydrate absorption and rate of digestion are dependent factors of glycemic index (Hallfrisch and Behall, 2000). There was considerable converse connection between occurrence of type 2 diabetes mellitus and cereal fiber, dietary fibers, magnesium, whole grains and total grains (Liu *et al*., 2000). The use of foods having low glycemic index illustrate direct link with decrease in subsequent appetite and/ or amplified the feeling of fullness resulting in lowering voluntary energy intake (Roberts and Heymam, 2000).

Soluble fiber reduces the postprandial glucose and insulin concentration in diabetic and non-diabetic persons. Soluble fiber shows lowering effect on plasma glucose and form gel-like solution in stomach that decrease the absorption and digestion of foods. Insoluble fiber also participates in

reducing the absorption process of food (Anderson, 1986).Fiber from fruits and vegetables was unrelated with the occurrence of diabetes while the consumption of cereal fiber show opposite response in the prevalence of diabetes (Salmeron *et al*., 1997).

Wheat fibers decrease the total cholesterol, low density lipoproteins, very low density lipoproteins and triglycerides level and increase HDL that are beneficial for human health (Jenkins *et al.,* 1999). Wheat with additional protein content lowers the serum cholesterol level. Fiber has protective effect that act as anti-oxidative stress agent and anti-clotting factor due to high protein vegetable content (Rezar *et al*., 2003). Insoluble dietary fibers show significant decrease in serum cholesterol with saturated and trans-unsaturated fat restricted diet. Soluble dietary fibers reduce serum cholesterol concentration more effectively than insoluble fibers (Brown *et al.,* 1999).

Processed wheat bran is more efficient in lowering serum cholesterol than raw wheat bran (Lingarde and Larsson, 1984). Bran feeding not only lower cholesterol, LDL and triglyceride level in serum but also raise HDL level in serum (Castelli *et al.,* 1977). Insoluble dietary fiber containing diet shows insignificant result in lowering serum cholesterol as compared to dietary fiber in rats (Anderson *et al.,* 1994). The following objectives are: to determine the nutritive value of wheat porridge; to investigate the effect of wheat porridge on hypercholesterolemia rats and to examine the relationship of wheat porridge with weight and glucose level.

MATERIALS AND METHODS

Twenty four albino rats of either sex were purchased from National Institute of Food Science and Technology, University of Agriculture, Faisalabad. The animals were kept under similar manage mental conditions in animal room of Department of Food Science and Technology. They were maintained at a temperature of 25 ± 1°C and relative humidity of 45 to 55% under 12-h light: 12-h dark cycle. Rats were housed in four cages; each group was comprised of six rats. The rats were provided with normal routine rat feed. The feed was made available twice a day, usually in the morning and evening. However, drinking water was available throughout 24 hours. Blood sugar level and body weight were checked. To evaluate the lipid profile blood sample was drawn. Atherogenic diet was offered to the rats for 0-21 days. The period of 0-21 days was considered as lead-in period to introduce hyperlipidemia in albino rats. The atherogenic diet was composed of Cholesterol 0.5% and Coconut oil 20% mixed in normal routine rat feed. After giving atherogenic diet, blood sample were taken to test the lipid profile. Body weight gain and blood sugar level were also measured. It was zero week evaluation. The same evaluation was repeated after providing wheat porridge in diet at 2 week and 4 week interval.

Proximate composition: The proximate analysis ((moisture, ash, crude protein, crude fat, fiber) on wheat porridge were determined by using AOAC methods. The moisture and ash were determined using weight difference method while determination of crude fat was done using Soxhlet and fiber content was done by micro Kjeldahl method (AOAC., 2000).

Biochemical Parameters: Blood glucose levels were determined by glucose dye oxidoreductase mediator reaction which is specific for glucose by glucometer Accuchek Active®. This is the latest and most modern method to determine the blood glucose level for the self diabetic control. This instrument is reported to very sensitive with measuring range 10mg/dl-600mg/dl. It gives precise results when test is performed within the range of 50°F to 104°F.

Cholesterol level of collected sera was measured by CHOD-PAP method (Stockbridge *et al.,* 1989).The triglycerides in the collected sera were determined by liquid triglycerides (GPO-PAP) method as described by Annoni *et al.* (1982).The high density lipoproteins (HDL) were assessed by HDL Cholesterol Precipitant method (Assmann, 1979).Serum low density lipoproteins (LDL) were estimated by following the protocol of McNamara *et al*. (1990).

Statistical Analysis: For the interpretation of results data collected were subjected to statistical analysis using analysis of various techniques with completely randomized design. Means of treatment were compared by Duncan's new multiple range test (Steel *et al.,* 1997).

RESULTS

Proximate Analysis: Proximate analysis is important to assess the quality characteristics of raw materials. Similarly, wheat porridge was analyzed for various parameters like moisture, crude protein, crude fat, crude fiber, ash and nitrogen free extract respectively (Table 1).

Table 1: Proximate composition of wheat porridge on as such basis

Sr. no	Proximate analysis	Percentages in 10g wheat porridge
1.	Moisture content	11%
2.	Crude protein	13.80%
3.	Crude fat	1%
4.	Crude fiber	2%
5.	ash	1.05%
6.	Nitrogen free extract	65.15%

Effect of without atherogenic and after atherogenic diet on rats: The atherogenic diet was composed of cholesterol 0.5% and coconut oil 20% mixed in normal routine rat feed. After giving atherogenic body weight, glucose, cholesterol and triglycerides was found significantly increased as compared to without atherogenic diet group in rat, whereas the HDL and LD was also found non-significantly difference in Table 2.

Body Weight: Mean comparison of body weight of weeks and different treatments on hyperlipidemia rats increased in

control in 4th week and decreased in 30gram of wheat porridge/100gram of normal diet in 4th weeks. Overall mean of body weight in treatments was found in control followed by 10 gram wheat porridge/100 gram of normal diet, 20gram wheat porridge/100 gram 0f normal diet and 30gram of wheat porridge/100gram of normal diet. However, the overall means of weeks was non-significantly decrease in 2nd week and also decrease in 4th week of the experimental study as compared to control group (Table 3).

Glucose: Mean comparison of serum glucose of weeks and different treatments on hyperlipidemia rats were non-significantly increased in control in 4thweek and decreased in 30gram of wheat porridge/100gram of normal diet in 2nd weeks. Overall mean of serum glucose in treatments was significantly found in control followed by 10 gram wheat porridge/100 gram of normal diet, 20gram wheat porridge/100 gram of normal diet and 30gram of wheat porridge/100gram of normal diet. Whereas, the overall means of weeks was non-significantly increased in 2nd week and decreased in 4th week of the experimental study (Table 3).

Cholesterol: Mean comparison of serum cholesterol of weeks and different treatments on hyperlipidemia rats were significantly increased in control in 4th week and decreased in 30gram of wheat porridge/100gram of normal diet in 4th weeks. Overall mean of serum cholesterol in treatments was significantly found in control followed by 10 gram wheat porridge/100 gram of normal diet, 20gram wheat porridge/100 gram 0f normal diet and 30gram of wheat porridge/100gram of normal diet. However, the overall means of weeks was significantly increased in 2nd week and decreased in 4th week of the experimental study (Table 3).

Triglycerides (mg/dl): Mean comparison of serum triglyceride of weeks and different treatments on hyperlipidemia rats was significantly increased in control in 4th week and decreased in 30gram of wheat porridge/100gram of normal diet in 4th weeks. Overall mean of serum triglyceride in treatments was significantly found in control followed by 10 gram wheat porridge/100 gram of normal diet, 20gram wheat porridge/100 gram of normal diet and 30gram of wheat porridge/100gram of normal diet. Whereas, the overall means of weeks was non-significantly increased in 2nd week and decreased in 4th week of the experimental study (Table 4).

High Density Lipoproteins (mg/dl): Mean comparison of serum HDL of weeks and different treatments on hyperlipidemia rats were non-significantly decreased in control in 4thweek and increased in 30gram of wheat porridge/100gram of normal diet in 4th weeks. Overall mean of serum HDL in treatments was non-significantly found in control followed by 10 gram wheat porridge/100 gram of normal diet, 20gram wheat porridge/100 gram 0f normal diet (16.50±0.73) and 30gram of wheat porridge/100gram of normal diet. However, the overall means of weeks was non-significantly increased in 2nd week and increased in 4th week of the experimental study (Table 4).

Low Density Lipoproteins (mg/dl): Mean comparison of serum LDL of weeks and different treatments of on hyperlipidemia rats were non-significantly decreased in control in 2nd week and increased in 10gram of wheat porridge/100gram of normal diet in 2nd weeks. Overall mean of serum LDL in treatments was non-significantly found in control followed by 10 gram wheat porridge/100 gram of normal diet, 20gram wheat porridge/100 gram 0f normal

Table 2: Mean ± SE of body weight, glucose, cholesterol, triglyceride, HDL and LDL without atherogenic and after atherogenic diet on rats

	Body Weight	Glucose	Cholesterol	Triglycerides	HDL	LDL
Without atherogenic diet	205.38±4.28	70.33±1.20	83.25±6.71	162.50±15.55	20.25±1.49	26.00±2.12
After atherogenic diet	294.46±4.07*	124.04±2.52**	241.50±10.20**	234.50±12.18*	20.00±2.48	38.25±6.40

*, ** show significantly different at P<0.05 and P<0.01

Table 3: Mean ± SE of body weight (g), glucose (mg/dL) and cholesterol (mg/dL) of weeks and different treatments of on hyperlipidemia rats

Groups	Body Weight			Glucose			Cholesterol		
	2nd Week	4th Week	Overall Means	2nd Week	4th Week	Overall Means	2nd Week	4th Week	Overall Means
A	317.75	325.25	321.50	122.00	130.25	126.13	257.00	259.50	258.25
	±13.98	±14.42	±9.41	±3.51	±3.95	±2.90A	±1.08a	±10.96a	±3.58A
B	305.00	301.50	303.25	121.25	114.00	117.63	247.50	235.50	241.50
	±4.08	±2.06	±2.22	±2.87	±4.36	±2.78C	±0.87b	±4.86bc	±2.63B
C	303.00	300.75	301.88	120.00	120.00	120.00	227.50	221.00	224.25
	±0.82	±4.13	±2.00	±1.29	±1.73	±1.00B	±1.66c	±8.98d	±1.68BC
D	297.50	295.25	296.38	118.00	115.00	116.50	223.75	218.75	221.25
	±7.09	±8.03	±4.98	±1.92	±3.56	±1.96C	±3.95c	±1.25e	±2.14C
Overall	305.81	305.68	305.75	120.31	119.81	120.06	238.94	233.69	236.29
Means	±4.42	±4.58	±3.13	±1.65	±2.01	±1.28	±3.98A	±3.80B	±2.13

Mean sharing similar letter in a row or in a column are statistically non-significant (P>0.05). Small letters represent comparison among interaction means and capital letters are used for overall mean; Group A: Normal routine rat feed 0-30days; Group B: Normal routine rat feed + 10gwheat porridge/100g, 0-30 days; Group C: Normal routine rat feed + 20gwheat porridge/100g, 0-30days; Group D: Normal routine rat feed+ 30gwheat porridge/100g, 0-30days

Table 4: Mean ± SE of body weight (g), glucose (mg/dL) and cholesterol (mg/dL) of weeks and different treatments of on hyperlipidemia Rats.

Groups	Triglycerides			HDL			LDL		
	2nd Week	4th Week	Overall Means	2nd Week	4th Week	Overall Means	2nd Week	4th Week	Overall Means
A	263.75	265.00	264.37	15.75	15.25	15.50	34.50	37.75	36.13
	±0.85b	±7.22a	±4.89A	±0.85	±0.63	±0.50	±3.844	±1.32	±2.33
B	247.75	244.25	246.00	15.50	15.25	15.38	45.75	36.50	41.63
	±3.54b	±6.60c	±3.11B	±0.29	±1.03	±0.50	±0.85	±3.07	±2.75
C	245.00	241.75	243.37	16.00	17.00	16.50	42.25	35.25	38.7
	±1.23c	±1.65c	±2.14B	±0.82	±1.29	±0.73	±1.75	±2.14	5±1.27
D	239.25	235.00	237.13	16.50	17.75	17.13	39.00	32.00	35.50
	±1.25d	±3.56d	±2.28B	±0.96	±0.85	±0.64	±0.82	±2.52	±2.40
Overall	248.93	246.05	247.49	15.81	16.44	16.13	40.38	35.81	35.50
Means	±2.55	±2.49	±1.76B	±0.34	±0.52	±0.31	±0.83A	±1.36B	±1.09

Mean sharing similar letter in a row or in a column are statistically non-significant (P>0.05). Small letters represent comparison among interaction means and capital letters are used for overall mean; Group A: Normal routine rat feed 0-30days; Group B: Normal routine rat feed + 10gwheat porridge/100g, 0-30 days; Group C: Normal routine rat feed + 20gwheat porridge/100g, 0-30days; Group D: Normal routine rat feed+ 30gwheat porridge/100g, 0-30da

diet and 30gram of wheat porridge/100gram of normal diet. Whereas, the overall means of weeks was significantly increased in 2nd week and decreased in 4th week of the experimental study (Table 4).

DISCUSSION

The recent research was conducted to investigate the effect of natural dietary fiber (wheat porridge) on hyperlipidemia rats. The indigestible component of cell wall is dietary fiber (Anderson, 1990). Human gastrointestinal enzymes are unable to digest these dietary fibers consisting of structural and storage polysaccharides (Judith *et al.,* 2002). Wheat is characterized as insoluble natural dietary fiber.

Proximate Analysis: The composition of wheat porridge was found moisture (11%), crude protein (13.80%), crude fat (1%), crude fiber (2%), ash (1.05%) and nitrogen free extract (65.15%). These results are comparable with the previous conclusions of (Rehman *et al,* 2007), it was reported that the whole wheat flour generally contained 10.82% moisture, 15.18% protein, ash 1.92%, 1.22 % crude fat, 2.08%% fiber and nitrogen free extract 68.78%.

Atherogenic Diet: The composition of atherogenic diet in present study was 0.5%cholesterol and 20% coconut oil to induce hypercholesterolemia in rats that significantly increased body weight, blood glucose level, plasma cholesterol, low density lipoproteins and serum triglycerides. Atherogenic diet composed of 0.3 % cholesterol, 10% coconut oil and 1% corn oil that significantly raised the plasma level of cholesterol and also increases the level of serum triglycerides but this increase was not significant (Hongmei *et al*, 1993). Navvarro *et al*. (2003) reported that feeding atherogenic diet to the hamsters significantly raised the level of plasma cholesterol, serum triglycerides, low density lipoprotein, serum glucose and body weight. Gavino *et al,* 2000 also advocated the same results on hamsters. Kris and Cooper, 1980 fed a high fat, high cholesterol diet to hypothyroid rats' results in intense hypercholesterolemia with a variable increase in plasma triglyceride.

Lipid Profile: Effect of wheat porridge on HDL and triglycerides level in hypercholesterolemia rats was non-significant (P>0.05). While effect of wheat porridge on LDL and cholesterol was found significant in hyperlipidemia rats (P>0.05). After giving 10, 20, 30g of wheat porridge in 100 g of normal routine rat feed, the level of cholesterol and low density lipoprotein were decreased significantly. Wheat fiber reduced serum cholesterol level by increasing the surface area for bile binding or altering the quantity of short chain fatty acids (Jenkins *et al*., 1999). Wheat fiber lowered the total cholesterol, low density lipoproteins, very low density lipoproteins and triglycerides level and increase HDL that are beneficial for human health (Jenkins *et al.,* 1999).The results of this study are not in agreement with Jenkins *et al.* (2002) as they examined the effect of wheat bran on diabetic patients having elevated cholesterol level. Wheat had insignificant impact on serum plasma and showed minor reduction in total cholesterol, LDL, triglycerides, body weight and blood pressure but had positive effect on health. Kerchoff *et al*. (2003) studied the comparative effect of wheat bran fiber and oat bran fiber in hypercholesterolemia subjects. No significant change in LDL cholesterol level in subjects consuming wheat cookies. In contrast to this study feeding of wheat bran 5g/kg body weight to the healthy males was responsible in decreasing total cholesterol and this reduction was due to fall of all lipoprotein classes (low density lipoprotein and triglycerides). This significant reduction in cholesterol was achieved by controlling diet, physical activity and white wheat bran prepared by AACC (Henegouwen *et al*., 1979). Anderson *et al*. (1994) reported that mixed dietary fiber diet (soluble and insoluble) showed intermediate decrease in plasma cholesterol and triglyceride while completely soluble dietary fiber was more effective in lowering plasma cholesterol than insoluble dietary fiber. Oat bran

supplemented diet with restricted saturated fats when fed to humans showed minor reduction in serum cholesterol. White wheat supplemented diet also gave same results as oat bran supplemented diet (Swain *et al*. 1990).

Body Weight and Blood Sugar: Body weight was decreased by giving wheat porridge and maximum weight loss was seen in rats providing 30g wheat at fourth week. But this weight loss was not significant. Likewise, serum glucose level was also decreased but that decrease was not significant. Vuksun *et al.* (2000) reported that body weight, fasting blood glucose, high density lipoprotein, total cholesterol and triglycerides remained unaffected after offering wheat supplemented diet. The results of this study are also in agreement with McIntosh *et al*. (1991) as they observed the effect of wheat and barley on lipid profile, body weight and blood glucose and concluded that barley and wheat both showed insignificant decrease in plasma cholesterol, triglycerides, body weight and blood sugar but barley was more effective than wheat due to its soluble properties.

Liu *et al.* (2003) stated the link between whole or refined-grain products and dietary fiber consumption with weight gain. High intake of whole grain products and dietary fiber indicate positive results in managing and sustaining desired ideal body weight. It was proved that whole grain foods were more beneficial in reducing body weight than refined grain products and dietary fiber intake also recommended as weight maintaining diet. Oat bran, wheat fiber and wheat germ were participated in lowering serum cholesterol but no effect on insulin responses or serum glucose. All dietary fibers lower chylomicron cholesterol (Cara *et al.* 1992).

Both soluble and insoluble dietary fibers involved in maintenance of body weight while insoluble dietary fiber were more effective in reducing the risks of diabetes mellitus (Weickert and Pfeiffer, 2008). Diet rich in dietary fiber and poor in carbohydrates contributed in lowering the risk of type^2 diabetes significantly by adjusting body mass index, age, diet, family history and other potential confounders (Schulze *et al*. 2004).

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